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EFFECT OF SPRAYING WITH FUNGICIDES ON THE KEEPING QUALITY OF FLORIDA CITRUS FRUITS

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MAJOR ROTS OF FLORIDA CITRUS FRUITS

Florida oranges and grapefruits are subject to three important rots during marketing. These are blue-mold rot and the two forms of stem-end rot. Practically all of the blue-mold rot is caused by the olive-green fungus *Penicillium digitatum*, but occasionally the blue-green *P. italicum* is responsible.

Blue-mold rot develops only after injuries have destroyed the naturally effective protective covering of the fruit and is prompt in showing up at ordinary temperatures. It can be reduced by stopping picking operations in periods of wet weather when fruit is tender, by careful handling to prevent injuries to the fruit, by

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[1] Until the season of 1925, John R. Winston, then pathologist in the Office of Fruit Disease Investigations, Bureau of Plant Industry, was in active charge of the field operations connected with this investigation. The writers acknowledge their indebtedness to him and to Frederick A. Wolf, Walter J. Bach, and John F. Wootten for very valuable help in the conduct of the work.

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keeping the fruit surface from remaining moist for any prolonged period, and by lowering the temperature during shipping and storage to retard the development of the rot, or by treating during packing with a protective antiseptic wash, such as a solution of borax.

The more common cause of stem-end rot is the Phomopsis stage of *Diaporthe citri* Wolf, which also produces the melanose blemish of the young fruit. The less common cause of stem-end rot is perhaps two or more species or strains of Diplodia which have been included rather indiscriminately under the name *Diplodia natalensis*. Both Phomopsis and Diplodia infest dead twigs in citrus trees and produce spores abundantly in these twigs. The spores seem to infect first some portion of the stem button while the fruit is on the tree, and advance into the fruit proper usually after picking. Both types of stem-end rot develop independently of injuries, are more serious in marketing than in the groves, and are very irregular in the time required for rot to develop after picking. They can be more or less effectively reduced by pruning out deadwood to reduce the source of infection, by spraying with an effective fungicide, by proper removal of the stem buttons immediately after picking (to prevent infection), by lowering the temperature during shipping and storage (to retard development of the rot), by treating the fruit with a solution of borax during packing, and by speeding up the marketing to insure consumption before development of considerable rot.

Blue-mold rot, because of its comparatively rapid development, is often apparent while the fruit is being packed or when it arrives at destination. The two stem-end rots may not develop until the fruit has passed through the intermediate channels of trade and reached the retailer or the consumer. The relative possible amounts of these three rots in carefully handled seedling oranges held at 70° F. may be judged from the experimental data hereinafter reported. (See fig. 3.) The high temperatures prevailing in early fall and late spring favor stem-end rot, especially the Diplodia type. Most of the Florida citrus fruit is shipped between Thanksgiving and Easter, when temperature conditions are more favorable for blue-mold and the Phomopsis form of stem-end rot.

A minor proportion of rot may be produced by miscellaneous fungi belonging to such genera as Colletotrichum, Gloeosporium, Alternaria, Fusarium, Rhizopus, Aspergillus, and Oospora. Most of these attack fruit that is reaching a condition of advanced decline or has been subjected to unusual conditions. Under ordinary conditions they are seldom of any great economic importance.

Most of the control measures for the major rots of Florida citrus fruits are applied after the removal from the tree. As a rule the grower of the fruit does not directly attend to the picking, packing, and shipping, but leaves these operations to the commercial packing houses. His responsibility for producing fruit of good keeping quality is restricted largely to the adoption of proper cultural and fertilizing practices for the production of good fruit and to the practice, when practicable, of two of the special control measures mentioned above, namely, the pruning out of deadwood and the spraying with an effective fungicide.

The pruning out of deadwood within the practical limits of economical grove operation has been found to have very little if any immediate effect in controlling Phomopsis stem-end rot.[2] It reduces Diplodia stem-end rot about 50 per cent. With Diplodia causing perhaps one-fourth of all the expected stem-end rot, this reduction would amount to one-eighth of the total stem-end rot, which is not enough to justify any special expenditures for pruning above what is ordinarily required in good grove practice. Probably the greater effectiveness of pruning against Diplodia rot is due to the fact that Diplodia is found for the most part on the larger twigs and limbs that can be rather thoroughly removed. It is not practicable to remove the innumerable small sprigs and fruit stems that regularly harbor Phomopsis, and so infection by this fungus is not materially checked by the ordinary pruning.

Spraying experiments conducted in Florida by the Office of Fruit Diseases during 1920 and the seasons following have shown that melanose, caused by the same fungus (Phomopsis) that produces the more usual type of stem-end rot, can be satisfactorily controlled by one application, made the latter part of April or early in May, of 3–3–50 Bordeaux mixture plus 1 per cent of oil as emulsion.[3] Figure 1, reproduced from the bulletin reporting that work, shows in diagrammatic form the relative effectiveness against melanose, during three of the seasons in question, of single applications of Bordeaux-oil emulsion at 10-day intervals over a period of about two months beginning about April 1.

EXPERIMENTAL METHODS

The present investigation, begun in 1920, has had for its object to determine what effect, if any, spraying the fruit with fungicides has on its keeping qualities. At the outset it was assumed that sprays applied in the fall or during the summer rainy season might be most effective for this purpose. With the development of extensive tests in April and May for melanose control, to which reference has been made, these experimental plots were drawn upon for samples for holding tests, thus covering the whole period of development of the fruit.

The experiments were conducted at Orlando, Fla. Large seedling orange trees with a considerable amount of dead twigs to harbor the stem-end rot fungi were used. Grapefruits were tested sufficiently on all important points to warrant extending to them the conclusions drawn from the tests on oranges. The spray was applied with paired angle disk nozzles and with a pressure of approximately 300 pounds or more. Ten to twenty-five trees, requiring about 8 gallons of spray to the tree, were included in each plot, and the plots were duplicated. The experimental grove regularly received a general oil spraying each year about July 1 and usually an additional application in the fall. These treatments successfully kept scale insects under control, even where several applications of Bordeaux mixture were made yearly. (Ordinarily citrus insect pests increase following the use of copper sprays, because of the control effect on their fungus parasites.) All plots were dusted with sulphur for the control of rust mites, or in the earlier years of the work were sprayed with dilute lime-sulphur solution for the same purpose. No appreciable fungicidal effect against melanose or fruit rots is to be attributed to these sulphur applications. The check plots were included in such insecticidal treatments.

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[2] WINSTON, J. R., FULTON, H. R., and BOWMAN, J. J. COMMERCIAL CONTROL OF CITRUS STEM-END ROT. U. S. Dept. Agr. Circ. 293, 10 p., illus. 1923.

[3] WINSTON, J. R., BOWMAN, J. J., and BACH, W. J. CITRUS MELANOSE AND ITS CONTROL. U. S. Dept. Agr. Bul. 1474, 63 p., illus. 1927.

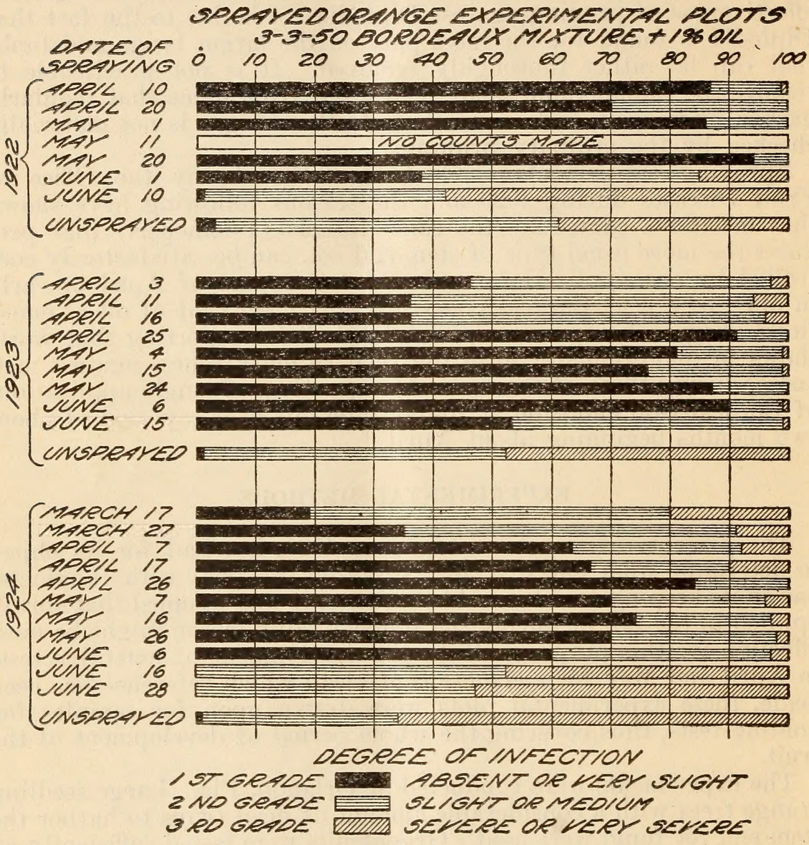

FIG. 1.—Percentage proportions of first, second, and third grade oranges, with respect to melanose infection, from experimental plots sprayed once with 3–3–50 Bordeaux mixture plus 1 per cent oil on the dates and for the years indicated. Mature fruit from these and similar plots were used for holding tests to determine the effect of spraying at various times on the keeping quality of the fruit during marketing

Samples of fruit were taken first when just mature enough for marketing and two or three times later at intervals of about three weeks, thus covering the normal marketing period for the fruit in question. Random samples of 50 fruits were taken in duplicate on each sampling date, giving a total of 300 fruits in the six lots for the full sampling of each spray treatment each season. In some seasons circumstances prevented the collection of this full sampling. The fruit was handled carefully to avoid injury that might lead to blue-mold infection.

In order to hold the fruit under conditions favorable for the development of any form of decay, it was placed unwrapped in open boxes in a constant-temperature room held at approximately 70° F. Wet cloths were used to maintain a rather high degree of humidity. These test conditions were much more severe than Florida citrus fruit ordinarily encounters in commercial channels, and the resultant rot was a maximum showing. It is assumed that the effectiveness of any treatment would be proportionately as great, if not greater, under less severe conditions. The fruit was examined at 3-day intervals over a period of 36 or more days. Cultures were made, to distinguish between the two organisms causing stem-end rot, as well as to diagnose accurately other rots not certainly recognizable in their early stages.

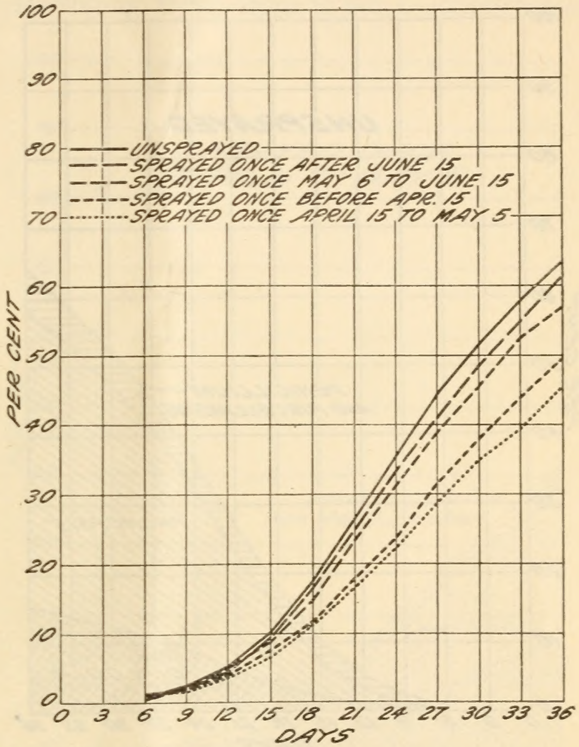

FIG. 2.—Development of all rots in oranges from plots receiving one application of 3–3–50 Bordeaux mixture plus 1 per cent oil and from unsprayed plots during the 36 days of the test. Each line shows unweighted average percentages based on all tests made during six years, 1920–1925, for plots receiving the spray application within the seasonal period indicated

SINGLE APPLICATIONS OF STANDARD BORDEAUX-OIL

In analyzing the effects of single applications of standard 3–3–50 Bordeaux plus 1 per cent oil[4] it is useful to combine results of those applications made during the period for best and surest melanose control, taken to be from April 15 to May 5. This is for two reasons—because melanose is likely to require such spraying in the very groves in which stem-end rot is most prevalent, and because there might be expected to be a correlation between the control of melanose and that of the form of stem-end rot caused by the same organism. Applications made before April 15 constitute another natural group. Practically all of these were made between March 25 and April 15 and showed very satisfactory control of melanose. The young fruit is known to pass out of its susceptible condition for melanose about June 15, and the rainy season starts at about that time, so this date is another convenient dividing point.

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[4] No material difference in effectiveness was noted between 3–3–50 and 3–4–50 Bordeaux-oil; some of the tests were made with one formula, some with the other. When applications were made soon after the blooming period, a reduction was made from 1 per cent to one-half per cent oil in the form of emulsion to avoid possible oil injury.

Figure 2 shows the total rot in unweighted averages of all tests made during the six-year period 1920–1925.

As has been indicated, the experiments were planned the first two years to include a relatively large number of tests during the rainy season and later. The interval between dates of spraying for successive plots was usually 10 days, but sometimes was as long as 15 days. A proper weighting of the averages would compensate for irregularities in the number of oranges in the samples as well as for the variations in numbers of tests included in the several periods and for the several seasons; but the form presented suffices for a practical showing of how general keeping quality of the fruit is affected by single applications made at various times and over a term of years of what has proved to be the most effective available fungicide. The best results came from spraying during the period of best melanose control, April 15 to May 5. Spraying before this period gave better results than spraying after it, which also agrees with the results obtained in melanose control. Very little benefit came from spraying in summer or fall.

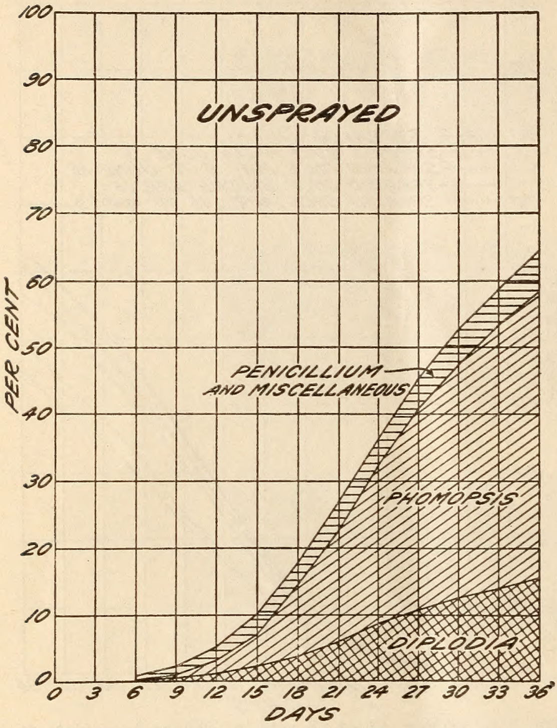

FIG. 3.—Proportions of various rots based on total oranges originally in the test, not sprayed, held 36 days. The percentages are based on collections made from a single old seedling-tree grove during five years, 1921–1925

The general conclusion is that a spray application properly timed for melanose control is the most effective for reduction of total rot after the fruit is picked.

EFFECTS ON VARIOUS ROTS

The proportionate amount of each constituent rot is shown in Figure 3 for unsprayed oranges and in Figure 4 for oranges sprayed once with 3–3–50 Bordeaux-oil April 15 to May 5. These graphs are based on the results of five seasons, 1921 to 1925. Since conditions influencing rot development and effectiveness of control measures varied from year to year, and since the number of tests and the amount of sampling also varied, it has seemed best to determine the average results for each season and to give these seasonal averages equal weight in calculating the general average for the five years. On this basis of calculation the total rot curve for unsprayed fruit is not materially different from that shown in Figure 2 for the unweighted average for six years, but the total rot curve for once-sprayed fruit is slightly lower.

Comparing Figures 3 and 4, it is seen that Phomopsis rot is greatly reduced in the once-sprayed fruit, and that Penicillium and miscellaneous rots are only slightly reduced during the first part of the holding period but are distinctly reduced later. During this later period the quick-developing Penicillium is not a considerable factor, and old-age rots, such as Colletotrichum and Fusarium, make their appearance. Diplodia rot is not materially affected in absolute amount. It must be remembered, however, that when the fruit is protected from other rots there is a proportionate increase in the chance for Diplodia rot to develop. The fact that the absolute number of cases of Diplodia rot remains practically unchanged, in spite of an increase in the fruit that is saved from other rots and so remains in the test long enough to develop Diplodia rot, means that the liability to development of this last rot is really reduced. This is further shown in Table 2 for four of the seasons in question, where one application of Bordeaux-oil is shown to have had an effectiveness of 19 per cent against Diplodia rot. The same treatment had an effectiveness of 60 per cent, or about three times as great, against Phomopsis rot.

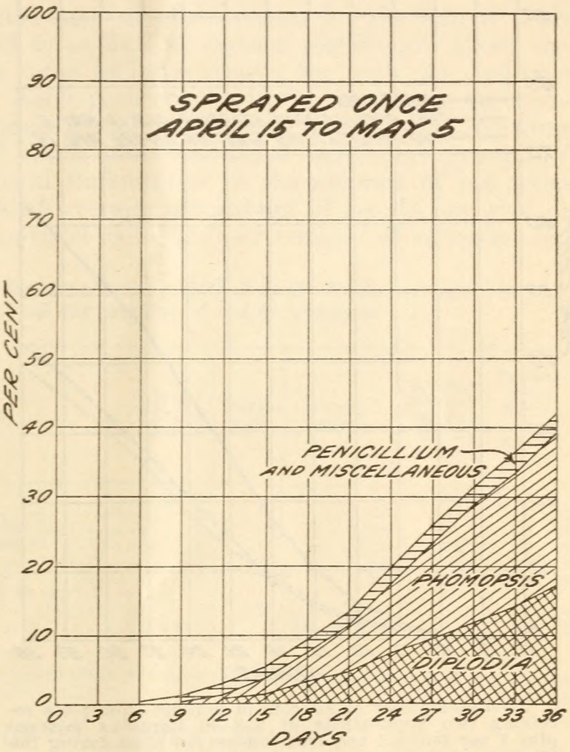

FIG. 4.—Proportions of various rots based on total oranges originally in the test, sprayed once with 3–3–50 Bordeaux mixture plus 1 per cent oil between April 15 and May 5, held 36 days. The percentages are based on tests made in the grove mentioned under Figure 3 and during the same five years

TWO OR MORE APPLICATIONS OF STANDARD BORDEAUX-OIL

In the case of the plots on which two applications of 3–3–50 Bordeaux mixture plus 1 per cent oil were made, the interval between sprayings of a particular plot was usually 10, 20, or 30 days.

In grouping these tests for Figure 5, account is taken only of the date of the first of the two applications. No showing is made of the treatments begun after May 5; these were too late to be highly effective.

It is apparent that there is only slightly increased benefit from two applications as compared with one well-timed application, not enough to justify the doubled expense of the spray operation. It will be noted that two-spray operations starting before April 15 gave better results than those started during the period for best single-spray control, April 15 to May 5. This is to be expected when one considers that in most cases the former plots received the second application some time during this period of best single-spray control and that their first application was during the second-best period. On the other hand, when spraying started during the period from April 15 to May 5, the second application fell, as a rule, during the third-best period for single-spray control.

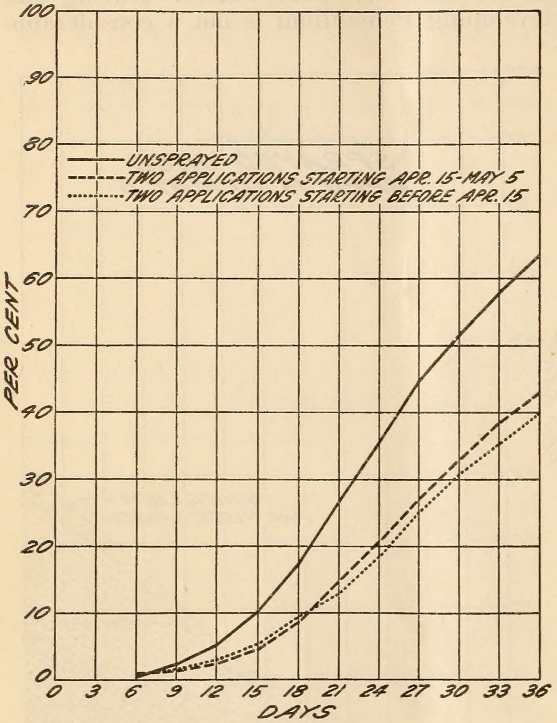

FIG. 5.—Development of all rots in oranges from plots receiving two applications of 3–3–50 Bordeaux mixture plus 1 per cent oil and from unsprayed plots during the 36 days of the test. Each line shows unweighted average percentages based on all tests made during six years, 1920–1925, for plots receiving the first of the two spray applications within the seasonal period indicated

Two-spray tests starting after May 5 were not very numerous for the reason that this line of testing was discontinued after two years, when it was clear that spraying begun so late gave relatively slight control. A considerable number of late-season plots were sprayed three or more times without showing as good control as was obtained by a single earlier application.

Three-spray tests during April and May gave better control than two-spray tests during the same period, but such a frequent schedule is not practicable.

EFFECTIVENESS OF ONE AND TWO APPLICATIONS OF BORDEAUX-OIL

The relative degree of effectiveness indicated by each of the several lines in Figure 2 has been calculated.[5] The term "percentage of effectiveness" is used for the final result. A 100 per cent of effectiveness means that no rot occurred. A 25 per cent of effectiveness means that one-fourth of the oranges that otherwise would have rotted were saved by the treatment; that is, a possible rot of, say, 10 per cent of the fruit would be reduced to an actual loss of 7½ per cent. A zero percentage of effectiveness indicates no control of rot whatever.

Table 1 gives the percentages of effectiveness for the lots of fruit shown in Figures 2 and 5, as well as certain particulars about the scope of the tests. The table includes results for both one and two applications of spray. Each percentage of effectiveness is an average for the number of seasons indicated and is based on the showing of rot from unsprayed check plots for these particular groups of seasons. With the natural fluctuations in the amount of rot from year to year, the figures of average percentage of rot do not give as accurate a basis of comparison as do the percentages of effectiveness.

TABLE 1.—*Results of spraying experiments with 3–3–50 Bordeaux mixture plus 1 per cent oil for control of rot in oranges*

Applications of spray	Number of seasons	Total tests	Total oranges	Average percentage of rot (36 day period)	Percentage of effectiveness (36 day period)
1 application before Apr. 15	4	10	2,200	19.3	27
1 application between Apr. 15 and May 5	5	10	2,050	17.7	33
1 application between May 6 and June 15	5	18	3,797	23.2	12
1 application after June 15	6	22	3,860	24.6	6
2 applications, starting before Apr. 15	4	14	3,350	15.2	42
2 applications, starting in period from Apr. 15 to May 5	5	16	3,533	16.3	38
Unsprayed checks [1]	4 to 6	--------	Up to 8,850	----------	0

[1] For each of the treated groups a special check was calculated, including the unsprayed plots for the particular seasons in question.

MODIFIED COPPER SPRAYS

Preliminary tests were made with a representative group of copper sprays and dusts to determine whether any gave promise of superiority over the standard 3–3–50 Bordeaux-oil formula. The tests were not repeated over a period long enough to justify extensive statistical treatment. However, the indications seem to be definite enough to warrant a summary of the results obtained but not to justify further extensive tests.

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[5] The average height of each line is calculated for any particular period, say 36 days, by adding the cumulative percentages of rot indicated at each 3-day interval along the line, and then dividing by the number of such intervals, in this case 12. This value would be the average percentage of rot developing in the lot of fruit represented by the line and would take into consideration the time at which the rot began to show as well as the total amount reached in the successive time intervals. The average percentage of rot thus obtained for each treatment is subtracted from that for the unsprayed check to determine the saving effected by the treatment. This difference is then divided by the average percentage for the unsprayed check to determine the percentage of rot that has been eliminated by the treatment.

In 1921 and 1922, tests were made of 1–1–50 Bordeaux-oil, using 1, 2, and 3 applications during the period for best rot control. One application of this spray was about half as effective, when all rots are considered, as 1 application of 3–3–50 Bordeaux-oil made at the same time. Two applications were slightly better than 1 application of the full-strength spray, but not so good as 2 applications of the latter. Three applications were about on a par with the same number of applications of the 3–3–50 Bordeaux-oil.

A 2–2–50 Bordeaux-oil was used in 1, 2, and 3 applications during 1922, with results about the same as for equal numbers of applications of 3–3–50 Bordeaux-oil. However, this reduction in the strength of spray below the standard 3–3–50 formula showed a distinct falling off in effectiveness in the case of melanose.

Tests were made in 1922 with neutral Bordeaux-oil in which just enough milk of lime was used to combine with the standard quantity of bluestone, and also with "improperly prepared" Bordeaux-oil in which concentrated stock solutions of bluestone and of lime were mixed before diluting. The first in 1, 2, and 3 applications was fully as good as the standard Bordeaux-oil. The second was distinctly less effective than the standard mixture in 2 and 3 applications. No test was made with single applications.

A copper soap spray containing one-half pound of copper sulphate and 3 pounds of resin-fish oil soap in 50 gallons of water was used during 1921 and 1922 in tests with 2 and 3 applications, and during 1921 in a 1-application test. It was slightly less effective than 3–3–50 Bordeaux-oil.

In 1925 two tests with two applications of 80–20 lime-copper sulphate dust were made on trees wet with dew. Instead of showing a gain in effectiveness the treated fruit developed about 10 per cent more rot than the untreated checks.

LIME-SULPHUR SPRAYS

During the four seasons of 1921, 1922, 1923, and 1925, lime-sulphur solution was tested in 1–40 dilution and in three-application schedules during the rot-control period, April 15 to May 5. The results are shown in Table 2.

During one of the four seasons in question no 3-application test of standard Bordeaux-oil was made; the two 2-application tests for that season have been included with the five 3-application tests for the other three seasons to furnish a basis for comparison. During these four years eight 1-application tests of standard Bordeaux-oil were made during the periods covered by the lime-sulphur schedules. The results of these are also included for comparison.

Considering all rots, three applications of 1–40 lime-sulphur solution were about one-fourth as effective as a single application of standard Bordeaux-oil spray and about one-fifth as effective as three applications of the latter. The effectiveness against the Phomopsis type of stem-end rot is in general about half as great as for the standard Bordeaux-oil. A surprising feature is that the Diplodia rot in the lots of fruit sprayed with lime-sulphur solution were about 50 per cent greater than in the unsprayed fruit.

In 1921, tests were made with 1 and 2 applications of 1–40 lime-sulphur solution and with 1, 2, and 3 applications of dry lime-sulphur made up at the rate of 4.4 pounds to 40 gallons of water. All 5 of these tests gave more rot in the sprayed fruit than in the unsprayed checks. This excess of rot in the sprayed fruit ranged from 17 to 36 per cent, and there was excess for Phomopsis as well as for Diplodia rot, relatively greater for the latter.

Table 2.—*Results of spraying experiments with 1–40 lime-sulphur solution and with 3–3–50 Bordeaux mixture plus 1 per cent oil for control of rot in oranges*

Spray and applications	Number of seasons	Total tests	Percentage of effectiveness for 36-day period		
			All rots	Phomopsis rot [1]	Diplodia rot [1]
1–40 lime-sulphur, 3 applications	4	5	11	33	[2] −51
3–3–50 Bordeaux plus 1 per cent oil, 2 or 3 applications	4	7	55	72	24
3–3–50 Bordeaux plus 1 per cent oil, 1 application	4	8	48	60	19
Unsprayed	4	0	0	0	0

[1] The percentages of effectiveness for Phomopsis and Diplodia considered separately are computed as follows: The 3-day rot caused by each fungus is divided by the number of fruits in the test during the particular 3-day period; these percentages are added cumulatively; an average of values of such cumulative index figures is obtained by dividing by the total number of 3-day periods covered in the test; such average for sprayed fruit is subtracted from a similar average for the unsprayed check, and the difference is divided by the average for the unsprayed check to determine the percentage of effectiveness.

[2] A minus value for the percentage of effectiveness means that the treated fruit developed more rot than the untreated checks.

Similar excess in rot occurred during 1925 in the case of two tests of 2 applications of 80–20 lime-copper sulphate dust. In this case the Diplodia rot was almost 75 per cent greater in the dusted fruit than in the untreated, the Phomopsis rot was about the same as in the untreated, and the resultant, including all rots, was about 10 per cent in excess of the total rot for the untreated fruit.

No explanation can now be offered for this peculiar effect of the lime-sulphur preparations and of the lime-copper sulphate dust in apparently favoring the development of the Diplodia type of stem-end rot.

PROLONGATION OF KEEPING PERIOD

From Figure 2 it is apparent that the oranges sprayed from April 15 to May 5 required about 2 days longer to develop 10 per cent of rot than did the unsprayed fruit, about 4 days longer to develop 20 per cent of rot, about 5½ days longer to develop 30 per cent of rot, and about 8 days longer to develop 40 per cent of rot. The unsprayed fruit showed these indicated percentages of rot in 15, 19, 22, and 25½ days, respectively, being increases of 13, 21, 25, and 31 per cent, respectively, over the time elapsing before these several proportions of rot developed in the sprayed fruit.

Probably nine-tenths of the Florida citrus fruit reaches destination within 2 weeks from the time it is picked, the major portion of it between 1 and 2 weeks after picking. A period of 3 weeks from the tree ought to cover actual consumption of most of this fruit.

The period of holding by jobbers, retailers, and consumers is, however, very variable, depending on a number of factors, and in some instances is quite prolonged. It is in such extreme cases that the protection given by the spraying is particularly valuable. Actual inspection reports show, in the course of a season, a considerable number of cases in which stem-end rot reaches 10 to 20 per cent or more at the time cars reach destination. Such fruit was probably exposed to considerable infection in the grove, or was subjected to unusually high temperatures or to considerable delay in handling, or to all of these conditions. Spraying in the grove to guard against the first of these contingencies would insure the fruit against much of the loss that might otherwise arise from the other two.

GENERAL DISCUSSION

The evidence presented shows that the same spray application that protects citrus fruits from melanose blemish prevents to a considerable degree their decay during marketing. This second benefit is obtained at no additional cost and is an added reason for spraying for melanose.[6] The various forms of decay are controlled in varying degrees, and none of them is entirely eliminated; hence the necessity for continuing to observe carefully other precautions that have been found to be helpful in preventing decay. Phomopsis stem-end rot was reduced in greatest degree, Diplodia stem-end rot less completely, and Penicillium blue-mold rot scarcely at all. The indications are that potential stem-end rot infection by Phomopsis occurs mainly during a limited period which one spraying covers rather effectively, while that by Diplodia occurs over a much longer period so that a single application of spray results in comparatively slight control.

Notwithstanding the use of oil emulsion in the Bordeaux mixture for spraying citrus trees, care must be taken to follow some weeks later with a special application of oil emulsion for scale-insect control. This would normally be made the last of June or first of July. If conditions warrant, an additional application should be made in the fall or during a mild period in winter. Proper measures should be taken to control rust mites if they appear.[7] In other words, in planning for the control of one blemish or pest, all others that require control should be taken into consideration. Nothing is gained by controlling melanose and then allowing the fruit to become russeted from rust-mite attack or the trees and fruit to be damaged by scale insects or white flies.

This experimental grove of seedling orange and grapefruit trees, about the average of a large acreage in Florida, has improved steadily in freedom from pests and in general vigor and productiveness during the six seasons of spraying with Bordeaux-oil for melanose control. No special ill effects have been noted where as many as three applications a year were made. Die-back and fruit ammoniation symptoms have practically disappeared from this grove during the period. Oil emulsion has been combined with the Bordeaux mixture and also has been used alone once or twice a year.

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[6] WINSTON, J. R., and BOWMAN, J. J. COMMERCIAL CONTROL OF CITRUS MELANOSE. U. S. Dept. Agr. Circ. 259, 8 p. 1923.

[7] YOTHERS, W. W. SPRAYING FOR THE CONTROL OF INSECTS AND MITES ATTACKING CITRUS TREES IN FLORIDA. U. S. Dept. Agr. Farmers' Bul. 933, 38 p., illus. 1918.

The net profits to the grower from spraying for melanose control may be conservatively estimated at 15 to 25 cents a box of oranges, with the cost of additional oil-emulsion spraying counted in. The additional value in improved keeping quality is obtained at no increase in cost. It may not always be realized in direct returns, for the reason that a large bulk of Florida fruit is marketed and consumed within the rather long period before the appearance of the rots that spraying reduces. Such spraying is good insurance against the occasional occurrence of unusually severe outbreaks of stem-end rot that strongly depress sale prices or throw the burden of later rot loss on the unsuspecting buyer. The reputation of Florida fruit for keeping will be ultimately improved by a more general practice of spraying in groves that are heavily infested with melanose. Fruit from such groves, mostly of the old seedling-tree type, is most likely to give trouble from decay, and the reputation of other fruit from cleaner groves may suffer undeservedly.

A prolongation of the keeping period of the fruit for a few days may mean the more successful supplying of the more distant markets, thus increasing the potential demand for the fruits. Proper spraying will tend to increase the effectiveness of other measures in bringing this about.

From the practical standpoint, when costs of spraying operations and benefit in control of melanose are considered, the best procedure is to use a single well-timed application of 3–3–50 Bordeaux-oil.

SUMMARY

The results of six seasons' tests show that citrus fruit from old seedling trees in Florida can be materially improved in keeping quality by spraying once between April 15 and May 5 with 3–3–50 Bordeaux mixture plus 1 per cent of oil in the form of emulsion. This is the regular treatment for melanose control.

By this means half or more of the Phomopsis type of stem-end rot was prevented over a prolonged holding period. The reduction of Diplodia stem-end rot was about one-fifth. Blue-mold rot and several miscellaneous minor rots were not materially affected.

The combined effectiveness against all rots amounted to a reduction of about one-third.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

April 6, 1927

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